The NATIONAL RDF 66 DIRECTION FINDER

NATIONAL COMPANY INC. MALDEN MASSACHUSETTS

Figure 1. The National RDF66 Radio Direction Finder

1. DESCRIPTION

1.1 **General** — Your National RDF66 is an accessory for use with your National NC66 Portable Receiver to provide a simple but efficient means of direction finding for small marine craft. It consists of a modified loop antenna mounted on an adjustable compass rose. The front panel contains a null indicator.

The loop may be rotated about the center of the compass rose. A pointer indicates its position with respect to the compass rose, which may be rotated with respect to the chassis. When your RDF66 is installed, the NC66 is tuned to a radio transmitter of known location, then the direction of the radio station from the vessel may be determined. If the RDF66 compass rose is adjusted so its 0° to 180° line is parallel to the keel, the relative bearing of the transmitter may be continuously checked. If the compass rose of the RDF66 is set to the compass heading of the vessel, the compass bearing of the transmitter may be read directly.

A three-foot cable permits the RDF66 to be installed a short distance from the NC66 or, it may be mounted on the receiver.

1.2 **Radio Direction Finding** — Due to the super conductivity of sea water, signals propagated across the surface of a large body of water travel in a straight line between the transmitter and receiver. The rf energy from the transmitter sets up lines of force which travel at the speed of light. A large number of such lines passing through a coil will induce a current. If a radio receiver has rotatable antenna coil with "bilateral" characteristics, it can be used to accurately determine the direction of receiver signals.

The antenna coil of the RDF66 is designed so that it will receive minimum signals when it is aligned in the direction of the transmitter. This setting is known as a "null." When the antenna is aligned at right angles to the transmitter a maximum signal results. For radio direction finding, the nulls are of greater value since they are sharper and easier to determine. Any deviation from the antenna null position results in a rapid increase in signal strength.

2. INSTALLATION

2.1 **General** — Your National RDF66 should be installed and calibrated with the same care that is given to a magnetic compass. It should be located where it is handy, but not where it is exposed to weather. It may be installed in the cabin or pilot house providing the walls are not metal. The RFD66 may be mounted for operation on top of the NC66; however, the three-foot connecting cable permits the direction finder and receiver to be operated side by side.

2.2 **Connections** — The electrical connections required to connect the RDF66 to the NC66 are shown in figure 2. Remove the rear dust cover from the NC66 and remove the small plug from the receptacle on the antenna terminal board. This disconnects the NC66 ferrite loop antenna. Plug the cable from the RDF66 into the receptacle from which the NC66 ferrite loop antenna plug was removed. The rear dust cover may now be replaced on the NC66 using the upper left-hand clearance hole for the RDF66 cable.

NOTE

This installation will not interfere with the normal entertainment value of the NC66 since it may be used as a regular receiver with the exception that the direction finding antenna has replaced the internal antenna and may be rotated for best reception.

A special mounting bracket is supplied with your RDF66. When a permanent location has been determined aboard your boat the bracket may be screwed in place parallel to the keel. The bottom of the RDF66 is equipped with two snap fasteners which allow the unit to be securely snapped onto the bracket. When you are through using the RDF66 it may be removed by a gentle upward pull. The next time you wish to use the direction finder it may be quickly snapped in place and will be accurately located relative to the keel of the vessel.

If your RDF66 is mounted on the NC66, the carrying strap on the NC66 should be first pulled up into the position for carrying. This helps to keep the direction finder in place.

2.3 **Location and Calibration** — If the compass rose is set with its 0° to 180° line parallel to the keel, all radio direction finder bearings will be relative to the ship's heading. Metal objects aboard the craft, the magnetic compass, masts, stays and antennae all contribute to diffraction effects which cause small errors in the readings of a direction finder. These errors may be compensated for by calibrating the RDF66 for the location at which it is to be used. This is done by anchoring within sight of a radiobeacon and taking simultaneous visual and radio bearings at 45-degree intervals from 0 to 315 degrees. A bearing deviation card similar to that used for compass correction can then be made. A sample card is shown on page 5. If the location of the RDF66 aboard the vessel is changed, or if antennae, masts or metal objects are removed or installed, your RDF66 should be re-calibrated for maximum accuracy.

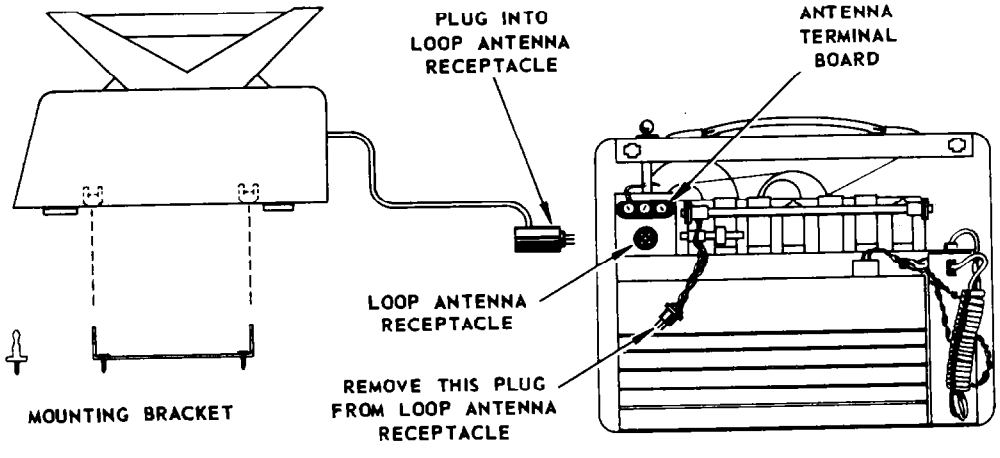


Figure 2. Installation Instructions

3. OPERATION

3.1 **Direction Finding Stations** — The United States Coast Guard maintains radiobeacons and radio direction finding stations on all coastlines of the United States and on the shores of the Great Lakes. These stations, which are geographically located to provide maximum accuracy and reliability, are the most desirable sources of radio navigation information. Each individual beacon and station is characterized by its own signal transmitted in the 285 to 315 kc frequency range. Three radiobeacon charts (one for the Atlantic and Gulf Coasts, one for the Pacific Coast and one for the Great Lakes) are bound in the back of the "Light List," published annually by the U.S. Coast and Geodetic Survey. These charts give the code, geographic location and operating frequency of all U.S. and Canadian radiobeacons.

Standard broadcast stations located close to the shoreline may also be used for radio navigation. Bearings taken on stations located inland are unreliable, since they are subject to serious refraction errors. On the other hand, standard broadcast stations are usually more powerful than radiobeacons, and can provide usable signals at greater distances. When navigating by means of standard broadcast stations be sure that the bearings are taken from the location of the transmitter and not the studio. Aeronautical radio range beacons which operate in the 200-415 kc band may also be used providing the transmitter location is known and is close to the coastline. In general, the most reliable signals for radio direction finding purposes are those which travel all the way over water.

Small craft owners who desire to obtain maximum advantage from the National RDF66 should obtain a copy of "Radio Navigational Aids" published by the Navy Hydrographic Office. This may be obtained from the U.S. Superintendent of Documents, Washington 25, D.C. (H.O. No. 203.22:205; 1955 edition, looseleaf with annual supplements; $5.00).

3.2 **Direction Finding Procedure** — The RDF66 Direction Finder is operative only when it is connected to the NC66 Portable Receiver, and the BAND switch of the NC66 is set at either DF or BC position, depending upon the frequency of the radio station to be tuned. The three other BAND switch positions connect the NC66 rod antenna to the receiving circuits for short-wave reception. Although the rod antenna is disconnected when the RDF66 is in use, it should always be kept fully collapsed. Otherwise stray pickup will interfere with the nulls.

Since the human ear is not sensitive to small changes in volume, the null indicator on the RDF66 provides the most accurate means of determining the direction from which radio signals are transmitted. A suitable direction finding radio station is tuned in and identified. The VOLUME control on the NC66 is adjusted so that the null indicator on the RDF66 reads about half scale. (Steadier meter readings on voice or music signals may be obtained by placing the CW-OFF switch on the NC66 to CW position.)

Adjust the TUNING control for peak reading on the null indicator, and then slowly rotate the

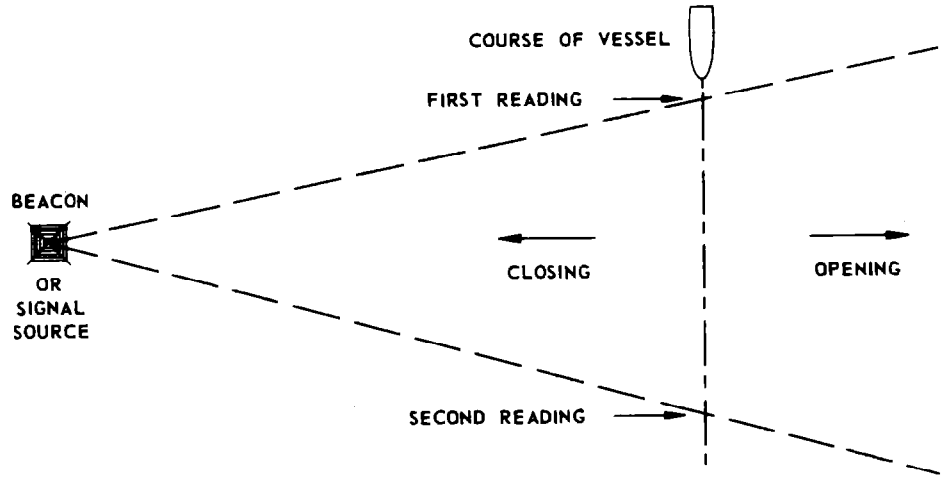


Figure 3. Determining Usable Null

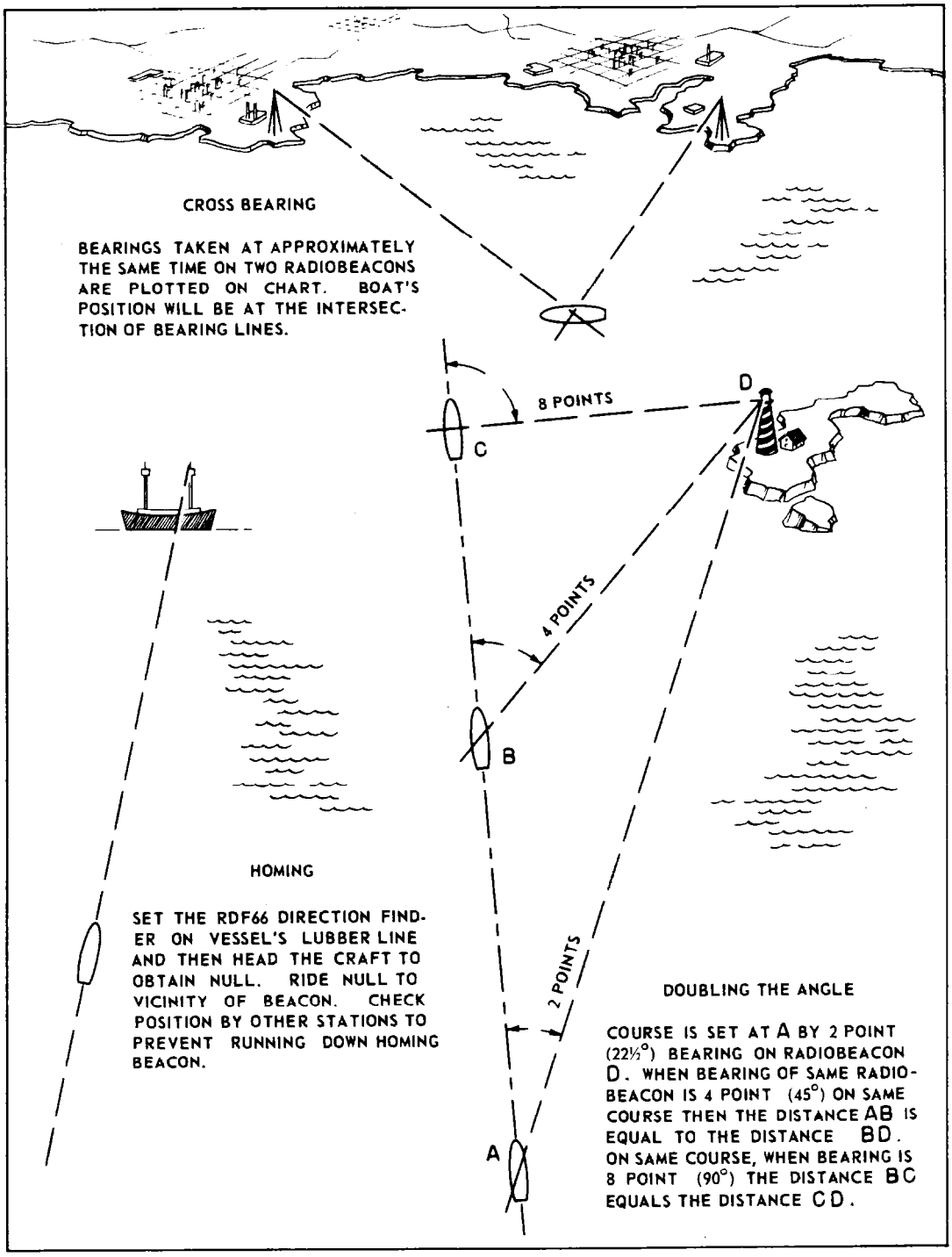


Figure 4. Navigational Uses of the RDF66

RDF66 antenna until a sharp null is observed. If the meter reading is very low at the null point, increase the volume slightly; the best null is one at which the meter needle does not quite touch the zero mark on the meter. Note the position of the RDF66 compass rose at this point and rotate the antenna 180 degrees, where a second null will be observed. In most cases, the general direction of the transmitter is known, or can be readily determined by a compass reading, and the correct null is obvious. When the correct null cannot be readily determined, two bearings on the same transmitter, taken at different locations, will give the true direction of the transmitter. When these bearings are plotted on a chart relative to the transmitter, as shown in figure 3, it will be seen that the lines close in the direction of the transmitter.

Once the direction of a known radio transmitter has been determined, the information can be used for navigating purposes. In general, radio bearings are used in the same manner as visual bearings. The transmitter may be used as a homing beacon or standard danger bearings, four-point bearings, doubling-angle bearings and many others may be taken from it. Relative bearings taken from two or more transmitters can be used to locate the position of a craft by crosspoint bearings. A diagram of three of the important navigational uses of the RDF66 is given in figure 4.

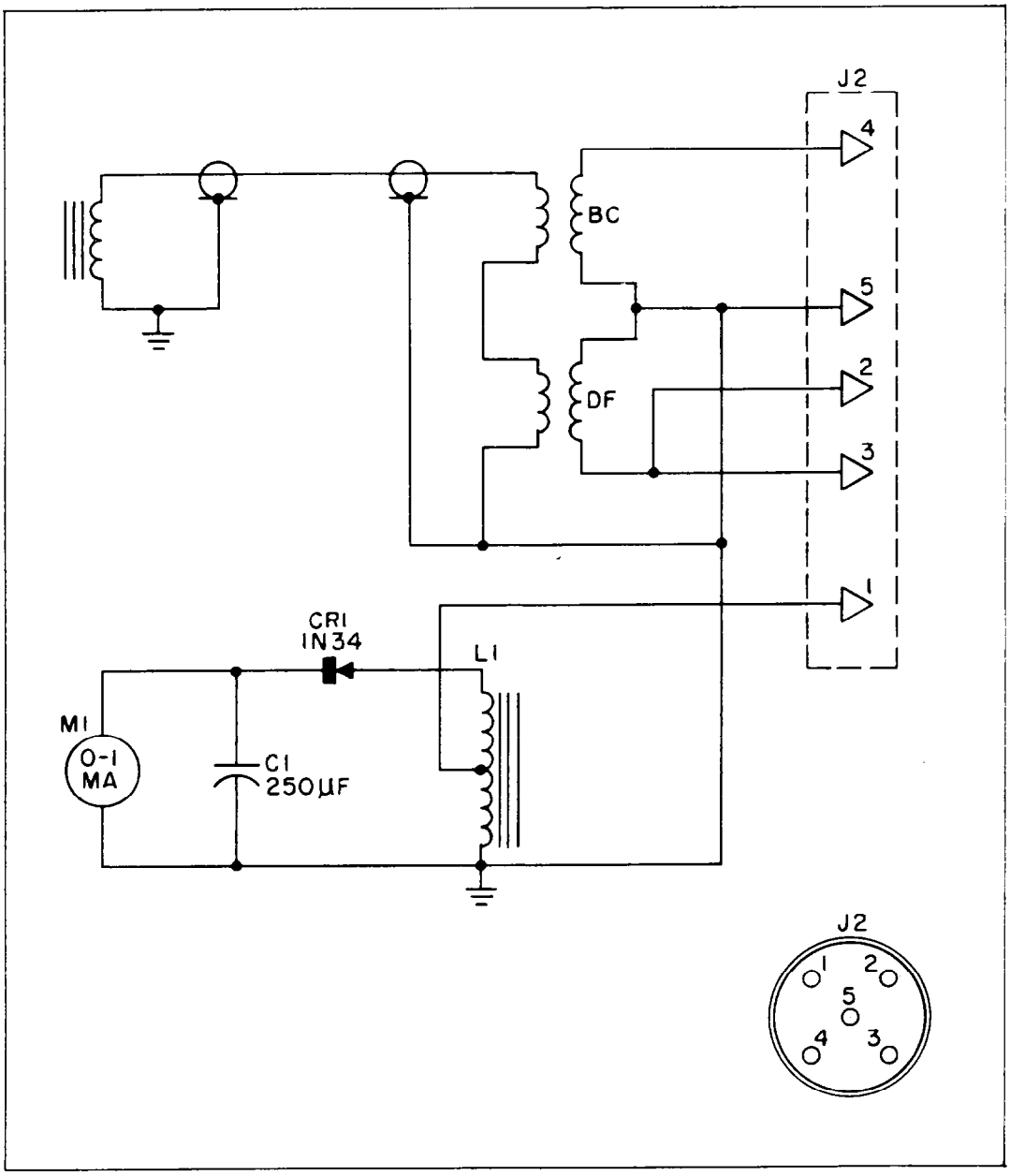
3.3 **Directional Errors** — Like all marine radio direction finders, the RDF66 is subject to errors due to "night effect" and "coastline effect." At night the magnetic lines of force from the transmitter are no longer horizontal, but are bent down by the ionosphere. "Night effect" may appear from one hour before sunset to one hour after sunrise if the distance from the boat to the transmitter exceeds 25 miles. It can also appear in the daytime off of a steep coastline. "Night effect" may be detected by continuous signal fading or by irregular placement of nulls (not 180 degrees apart). Under these conditions the true direction of a transmitter may be found by taking a number of bearings at regular time intervals and averaging them. Ionospheric phenomena are random and will average out to zero over a period of time.

"Coastline effect" is caused by the fact that radio waves are propagated more slowly over land than over water. This results in scattering at the coastline, causing serious errors in bearings taken on inland stations. Bearing information may be unreliable if the transmitter is located a distance inland, or if the bearing line intercepts the coastline at an angle of less than 15 degrees.

3.4 **Radio-audio Signals** — Many radiobeacons are equipped to transmit synchronized radio and sound signals. Sound travels in air at the rate of approximately one mile in five seconds; radio signals are transmitted almost instantaneously. A boat within audible range of one of these stations may determine its approximate location by first finding the direction of the station in the normal manner and then measuring the time, in seconds, between the reception of the radio and sound signals. The difference in reception time divided by 5.5 gives the approximate distance of the boat from the radiobeacon, in nautical miles (divide by 5 for statue miles).

BEARING	DEVIATION	COMPASS ROSE READING
0 45 90 135 180 225 270 315		
DATE: REMARKS:		

TYPICAL BEARING DEVIATION TABLE



SCHEMATIC DIAGRAM

RDF66 DIRECTION FINDER